Chicago Illinois USA

Implementing Energy Efficient Projects

Energy Audit of Buildings in Slovakia

Slovak University of Technology

Faculty of Civil Engineering in Bratislava

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- ✓ Key Number Calculation
- ✓ Energy auditing (Scanning, Implementation, O&M,...)

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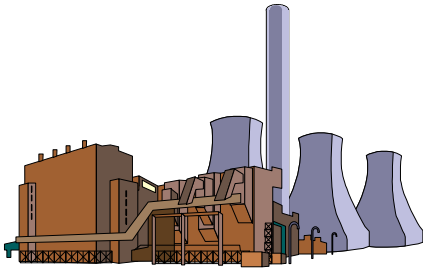
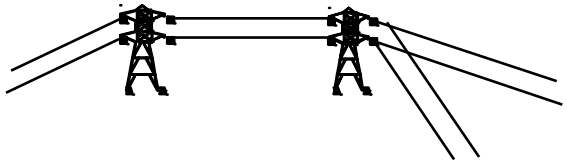
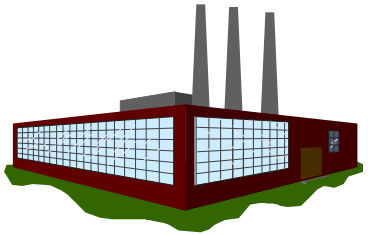
- ✓ Sotware EAS v1.0
- ✓ Energy auditing in Slovakia

The total energy system

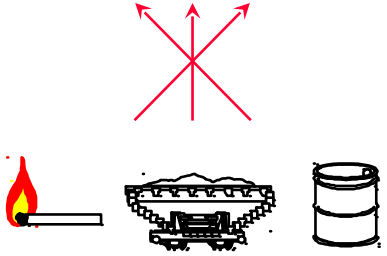
Production **Distribution** **Consumption**







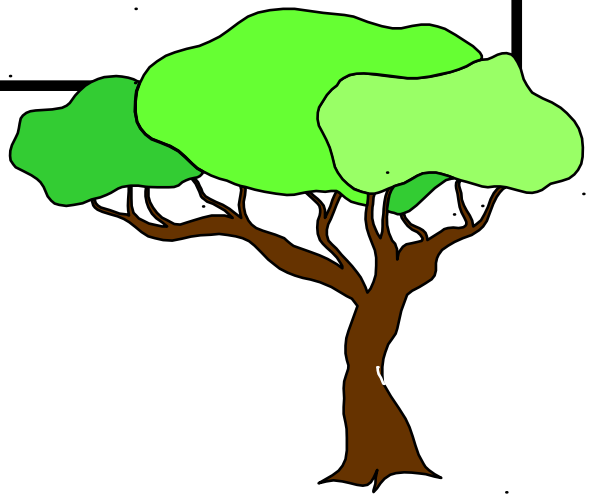
Industry



Buildings

Energy Conservation ?

ENergy CONservation (ENCON) :
is saving energy with
an economic and environmental profit !



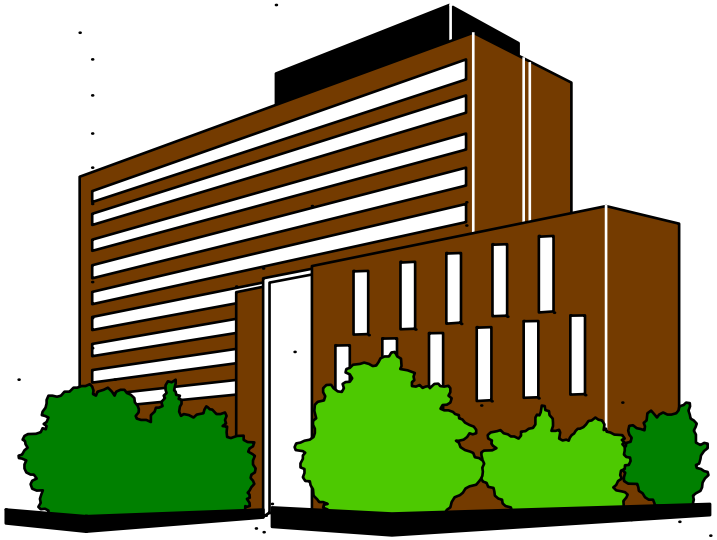
What is influencing the Energy Conservation Potential ?

HVAC systems

Building envelope

Electrical systems

Operation / user pattern



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ENCON Potential

Building: ENSI® Head Office, Oslo			Project no: 10130		Heated area: 2.300 m²	
ENCON measures	Investment [USD]	Net saving [kWh/yr]	Net saving [USD/yr]	Payback [year]	NPVQ*	
1. Energy efficient showers	400	2 300	200	2,0	2,51	
2. O&M manuals / Energy managem.	15 000	81 000	7 100	2,1	2,32	
3. Sealing of windows	10 000	80 000	8 000	1,3	2,28	
4. Insulation of attic	12 500	17 800	1 800	6,9	0,79	
5. Insulation of pipes, etc.	9 500	17 700	1 800	5,3	0,73	
6. Balancing and thermostatic valves	22 500	53 800	5 400	4,2	0,69	
7. Heat recovery, ventilation system	25 000	37 000	3 200	7,8	0,17	
8. Automatic control	20 000	38 000	3 300	6,1	0,16	
Total ENCON measures	114 900	327 600	30 800	3,7		

*) Real interest rate 7%

Energy Conservation Project

Objectives :

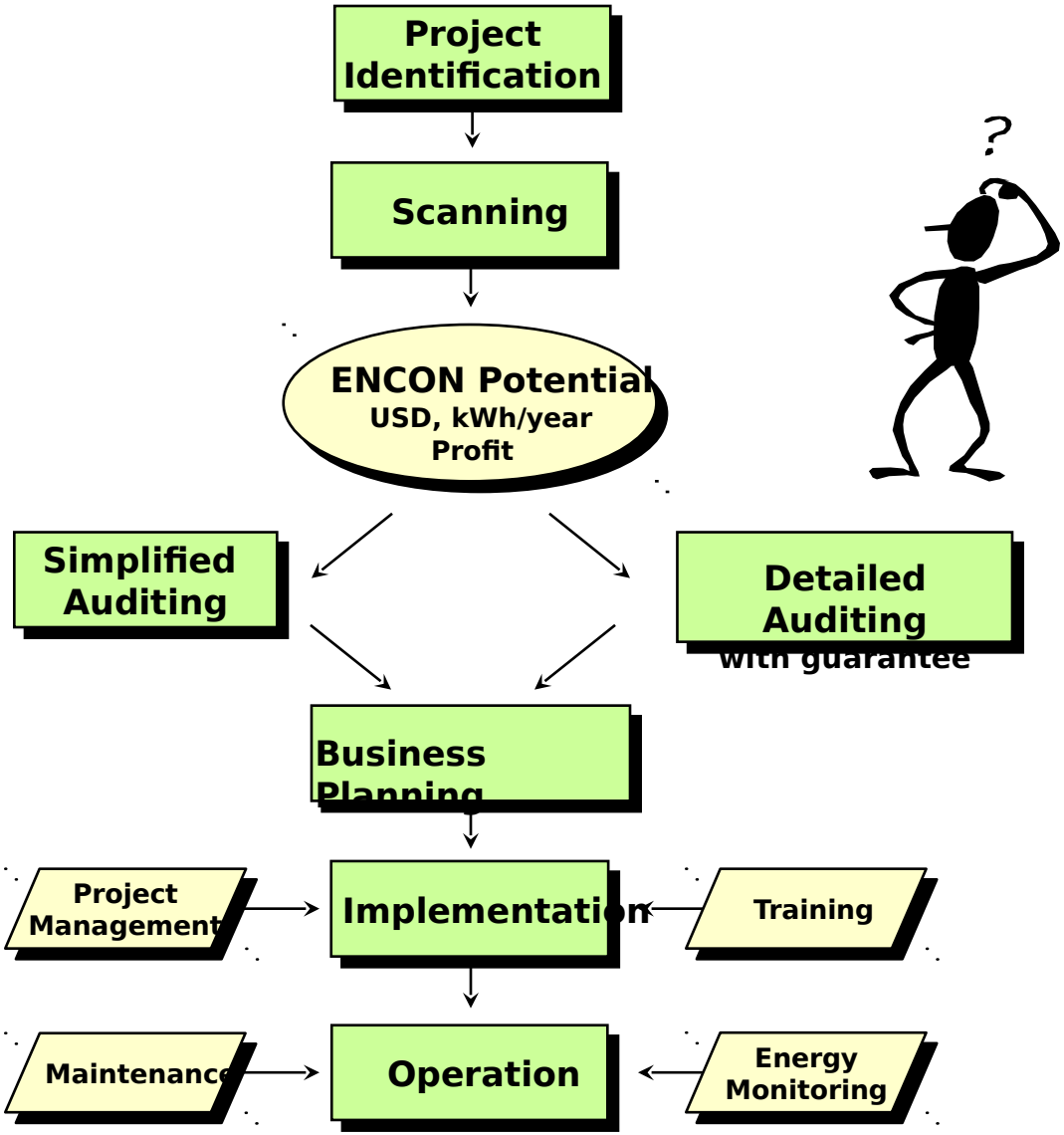
1.
2.
3.

Evaluation of the ENCON potential

Implementation in order to achieve profitable energy savings

Achievement of calculated energy saving potential and keeping it permanently on the right level

The ENCON Process



EU Directive on the Energy Performance of Buildings

Objectives :

To promote the improvement of the energy performance of buildings through cost effective measures (new and existing buildings)

The Directive require the following to be introduced:

- ✓ **Methodology for calculating the energy performance of buildings;**
- ✓ **Application of performance standards for new and existing buildings**
- ✓ **Certification schemes for buildings;**
- ✓ **Regular inspection and assessment of boilers, heating systems and**

To identify "Cost effective measures" → Energy Auditing

Energy Audit – ENCON Potential

Multidisciplinary energy calculations needed

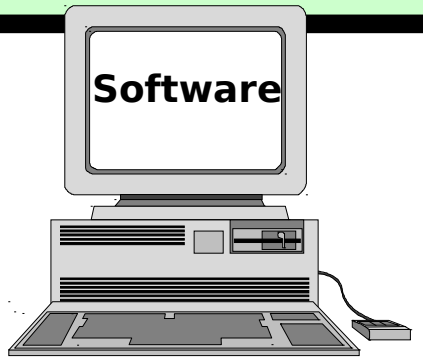
Energy Calculations

(EN 832, prEN 13790)

A number of input parameters:

- ✓ **Thermal characteristics of the building;**
- ✓ **Building design, position and orientation;**
- ✓ **Infiltration;**
- ✓ **Indoor climate;**
- ✓ **Internal heat loads;**
- ✓ **Lighting;**
- ✓ **HVAC installations;**
- ✓ **Automatic controls;**
- ✓ **……..**
- ✓ **……..**
- ✓ **Outdoor climate, incl. influence of solar radiation**

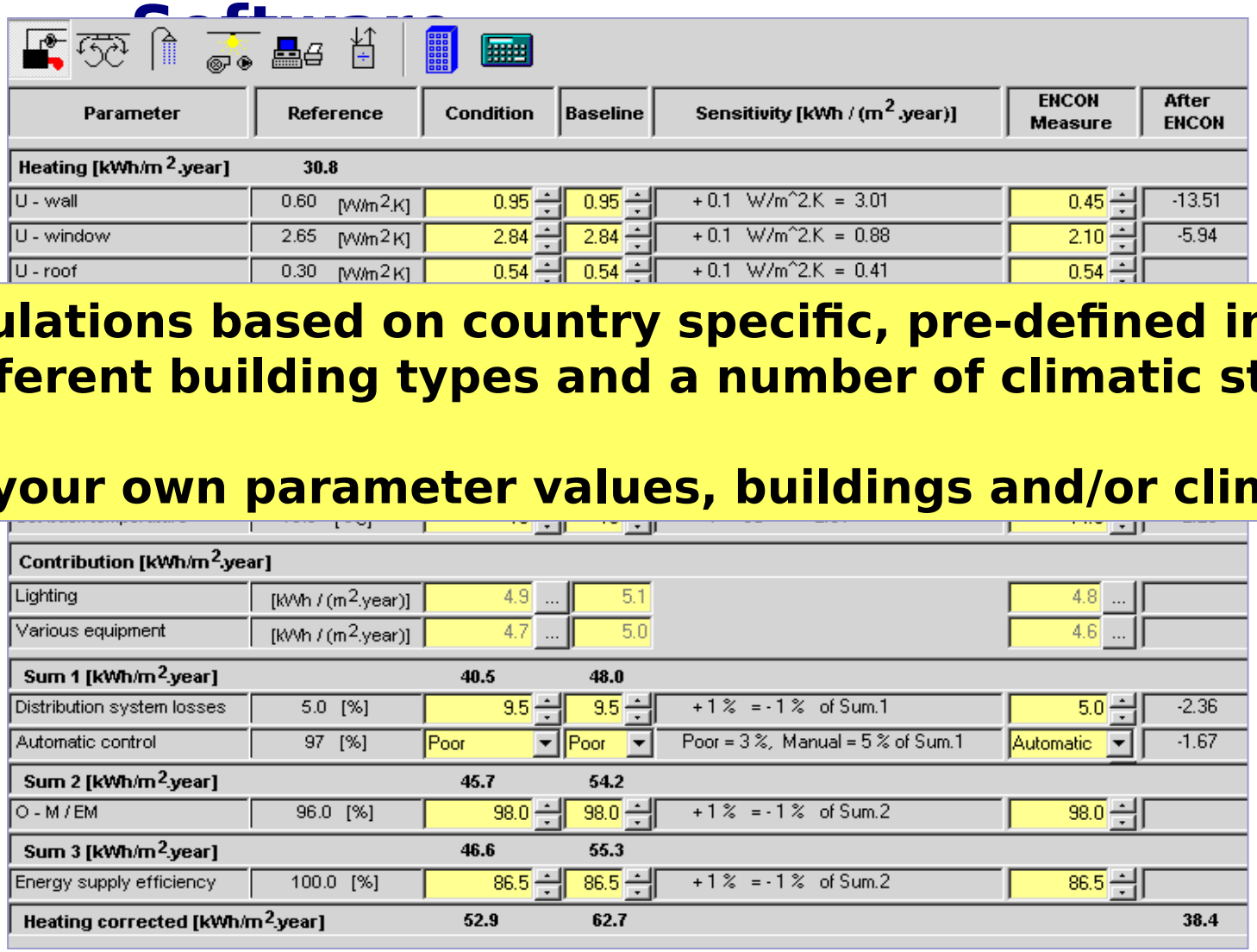
To find the cost efficient measures, several alternatives to be evaluated



The Key Number Software

Parameter	Reference	Condition	Baseline	Sensitivity [kWh / (m^2.year)]	ENCON Measure	After ENCON
Heating [kWh/m^2.year]	**30.8**					
U - wall	0.60 [W/m^{2}K]	0.95	0.95	+0.1 W/m^2.K = 3.01	0.45	-13.51
U - window	2.65 [W/m^{2}K]	2.84	2.84	+0.1 W/m^2.K = 0.88	2.10	-5.94
U - roof	0.30 [W/m^{2}K]	0.54	0.54	+0.1 W/m^2.K = 0.41	0.54	
U - floor	0.20 [W/m^{2}K]	0.65	0.65	+0.1 W/m^2.K = 0.41	0.65	
Form - factor	0.31	0.31				
Window area	15 [%]	15				
Energy supply efficiency	100.0 [%]	86.5	86.5	+1 % = -1 % of Sum.2	86.5	
Heating corrected [kWh/m^2.year]		**52.9**	**62.7**			**38.4**

The Key Number



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U - roof	0.30 [W/m^2.K]	0.54	0.54	+0.1 W/m^2.K = 0.41	0.54	
Contribution [kWh/m^2.year]						
Lighting	[kWh / (m^2.year)]	4.9	5.1		4.8	
Various equipment	[kWh / (m^2.year)]	4.7	5.0		4.6	
Sum 1 [kWh/m^2.year]		**40.5**	**48.0**			
Distribution system losses	5.0 [%]	9.5	9.5	+1 % = -1 % of Sum.1	5.0	-2.36
Automatic control	97 [%]	Poor	Poor	Poor = 3 %, Manual = 5 % of Sum.1	Automatic	-1.67
Sum 2 [kWh/m^2.year]		**45.7**	**54.2**			
O - M / EM	96.0 [%]	98.0	98.0	+1 % = -1 % of Sum.2	98.0	
Sum 3 [kWh/m^2.year]		**46.6**	**55.3**			
Energy supply efficiency	100.0 [%]	86.5	86.5	+1 % = -1 % of Sum.2	86.5	
Heating corrected [kWh/m^2.year]		**52.9**	**62.7**			**38.4**

ck calculations based on country specific, pre-defined input valu
for different building types and a number of climatic stations,

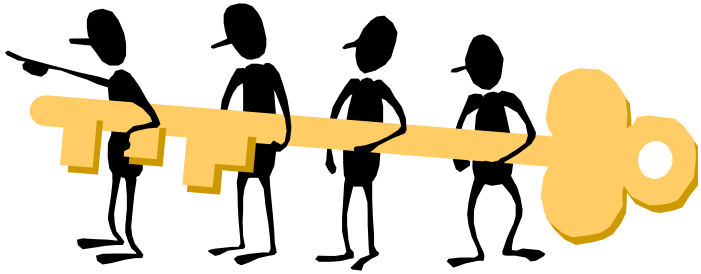
define your own parameter values, buildings and/or climatic dat

Energy evaluations and calculations

What is an Energy Efficient building?

190 kWh/m² year = energy efficient ?

Key Numbers



The Key Numbers, Oslo, Norway

Building type	"Older" buildings kWh/m²yr	Building codes 1987 kWh/m²yr	Building codes 1997 kWh/m²yr
Office building	213	188	149
Nursing home	306	300	239
Kindergarten	215	179	131
Schools	192	170	129
Universities	205	214	166
Apartments	207	191	140
...			

The Key Numbers, Oslo, Norway

ENSI Key Numbers are guideline values for energy demand in buildings having implemented profitable measures.

= “Energy Performance Requirements” according the EU Directive; for building new and renovating existing buildings bigger than 1.000 m²

Key Numbers for Bratislava and Poprad

- Apartment buildings
- Hospitals
- Kindergartens
- Office buildings
- Schools (without gymnasium)
- College and Universities (without gymnasium)
- Warehouses (15 °C)

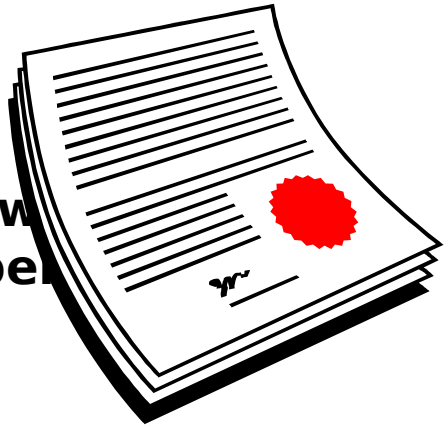
Climatic zone: *Bratislava*	Office buildings			
	Older buildings		1998 building codes	
	kWh/m²	W/m²	kWh/m²	W/m²
1. Heating	56,7	40	43,3	35
2. Ventilation	1,4	17	16,7	28
3. Hot water	15,8	37	15,8	37
4. Fans &pumps	2,5	3	9,0	3
5. Lighting	15,9	8	15,9	8
6. Various	8,7	5	8,7	5
7. Cooling	0	0	0	0
Total	100,9		109,3	

Energy Performance Certificates

An Energy Performance Certificate shall be made available for all buildings bigger than 1.000 m² that are constructed, sold or rented out.

To prepare a Certificate, an Energy Audit must be performed:

- ✓ **Inspection**
- ✓ **Calculation**
  - ➢ **Results (kWh/m²)**
- ✓ **A Certificate to be issued, building compared w**
  energy performance requirements (Key Numbe

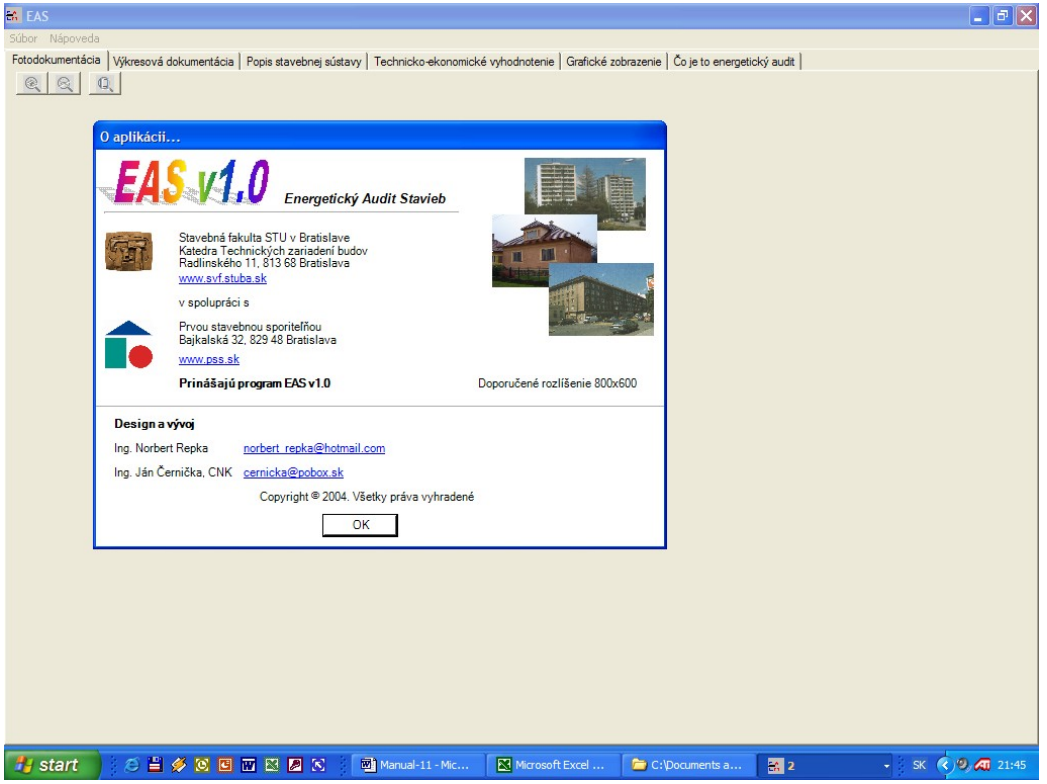


Introduction

- Until year 2000 were built18 386 dwelling houses
- The number of flats in those dwelling houses is 747 541
- 45% of citizens in Slovakia live in dwelling houses
- The rest of people live in single family houses
- Active approach by saving energy:
  - Slovakia is importing 90% of their energy (10% - coal)
  - Protecting the environment
  - Citizens vs. Economy influence
- Reducing the energy consumption in buildings - top priority in Slovakia

The application...

- Faculty of Civil Engineering
- First Building Society Savings Bank
- Program EAS v1.0
- Energy Audit of Buildings
- Quantifies the most effective energy measures in Buildings



Energy efficiency of buildings in Slovakia

- The energy efficiency, except of other influences, is dominantly dependent on the physically properties of the building envelope
- The assumption of their quality is given through the technical standards
- Dividing the construction of buildings follows the validity of our national standards:
  - Till 1950 were built buildings from brick, square roof (mostly wooden)
  - 1951 – 1970 beginning of prefabrication, using of light beton (porous beton)
  - 1971 – 1983 beginning of laminated constructions (sandwich construction), light building envelopes (metal-plastic basis)

EAS v1.0 vs. Key Number Software

- It is a database which utilize the results of the existing Key Number Software
- Energy calculation – Key Number Software
- Economy calculation, payback rates – EAS v1.0
- Simplified audit
- For purposes of the First Building Society Savings Bank

Key Number Software

- Based on CEN 832 and NS 3031
- Specific energy consumption (kWh/m^{2}year)
- The Key Numbers provide a direct expression of the energy efficiency of the building through tree levels:
  - Level 1: total energy consumption
  - Level 2: breaking into budget items
  - Level 3: for each parameter
    - Results for EAS v1.0

SEASON	BUDGET ITEM	ENERGY SOURCE
Winter All year	1. Heating 2. Ventilation 3. Domestic hot water	Gas, district heating, oil, coal, electricity, solar power
Summer	4. Fans/pumps 5. Lighting 6. Various 7. Cooling	Electricity Electricity Electricity, gas Electricity
	8. Outdoor	

EAS v1.0

- Quick and easy handling application based on European standard
- The database contains:
  - 42 apartment buildings (most built)
  - 8 typical single family houses
- Countable in two climatic zones (-12°C and -18°C)
- Structure of EAS v1.0:
  1. Photo documentation
  2. Drawing documentation
  3. Building description
  4. Energy – economy calculation
  5. Grafical presentation
  6. What is an energy audit...

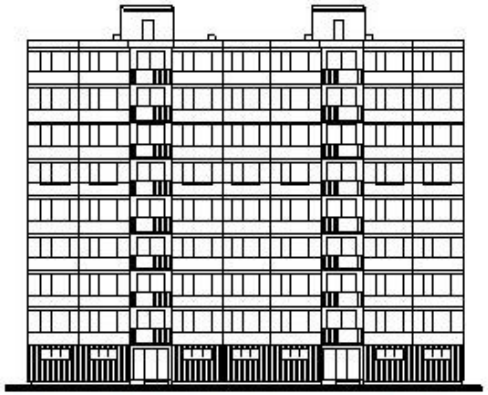
EAS v1.0 - structure

1. Photo documentation

- View on the selected type of building
- Identification of the building

2. Drawing documentation

- Technical recods (ground-plan, typical floor,...)
- Necessary dimensions (calculation of heated areas,...)
- Description of BE, HS, HW

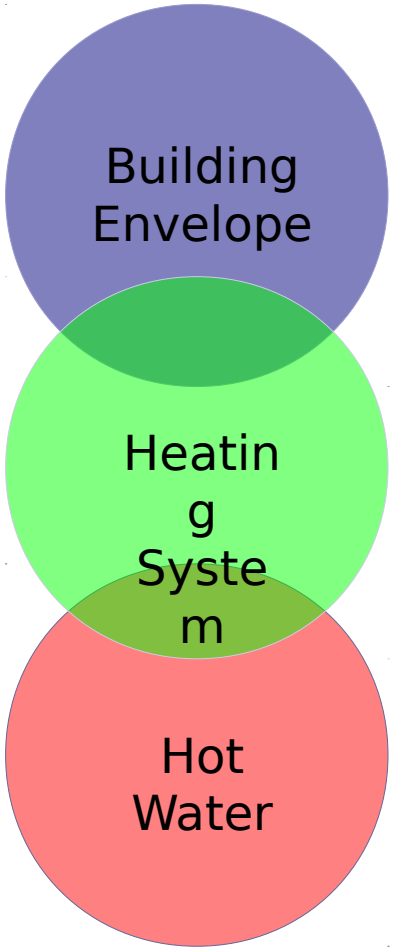


Pohlad na bytový dom stavebnej sústavy PS-82-PP

EAS v1.0 - structure

3. Energy – economy calculation

- Calculations of:
  - Energy savings
  - Investments
  - Profitability
- Calculate measures individually (depends on the customer)
- Three basic domains of energy measures:



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Three basic domains of energy measures

Prof.	Application of measurement	Energy saving measures
BE	Building Envelope	Insulation of external walls
		Insulation of floor or insulation of unheated basement
		Insulation of roof
		New windows

Table 1 Energy saving measurements of Building Envelope

Prof.	Application of measurement	Energy saving measures
HS	Heating System	Automatic control system and temperature set back for HS
		Insulation of pipes, valves,... on the HS
		Reconstruction of boiler room (new boiler, accessories,...)
		Balancing of the HS and installation of thermostatic valves

Table 2 Energy saving measurements of Heating System

Prof.	Application of measurement	Energy saving measures
HW	Hot Water	Water saving shower heads
		Thermostatic mixer, showers
		New automatic control system on the HW
		Insulation of pipes, valves,... on the HW

Table 3 Energy saving measurements of Hot Water

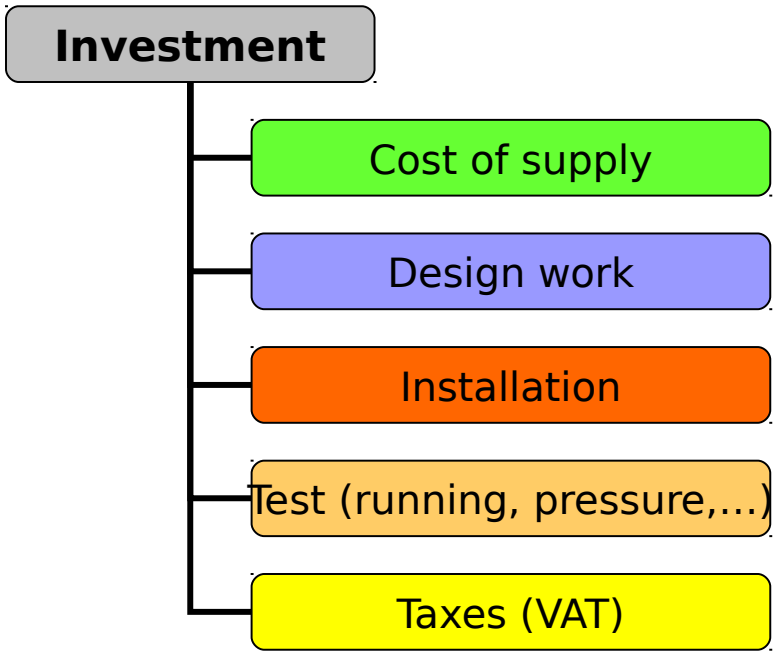
Energy potenci al

Profession	Measurements	Percentage of energy saving possibilities
BE	Building Envelope	20 - 30 %
HS	Heating System	10 - 25 %
HW	Hot Water	5 - 10 %

Table 4 Energy potential for individual energy saving measures*

Input values:

- Cost of GJ heat or m3 of natural gas
- Calculation of the whole building vs. just one flat
- Investments for the profitability calculations are running behind and they contains from costs of:



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Energy – economy calculation example

PS-82-PP radovy 8NP BA

Súbor Nápoveda

Fotodokumentácia | Výkresová dokumentácia | Popis stavebnej sústavy | Technicko-ekonomické vyhodnotenie | Grafické zobrazenie | Čo je to energetický audit

Vykurovaná plocha bytového domu: 2632 [m2]

Prepočítať

Cena: Pre celý bytový dom / Pre jednu bytovú jednotku

Cena za GJ tepla: 540 [Sk/GJ]

Cena za m3 zemného plynu: 10,0 [Sk/m3] — Podľa ceny zemného plynu

Uplatnenie opatrenia		Opatrenie	Pre celý bytový dom						
			Úspory		Investície		Návratnosť		Cena/m2
			Energia	Ekonom	Min.	Max.	Min.	Max.	Priemer
			kWh/rok	Sk/rok	Sk	Sk	rokov	rokov	Sk/m2
Stavebné konštrukcie	1	Zateplenie obvodového plášťa	23951,2	46561,1	1001955,0	1492905,0	21,5	32,1	473,9
	2	Zateplenie podlahy, resp. stropu nad nevykurovaným podlažím	1579,2	3070,0	193342,7	301467,6	63,0	98,2	94,0
	3	Zateplenie strechy	1052,8	2046,6	353333,5	405468,3	172,6	198,1	144,1
	4	Výmena transparentných výplní	72906,4	141730,0	2083950,0	2652950,0	14,7	18,7	899,9
		Spolu	99489,6	193407,8	3632581,0	4852791,0	18,8	25,1	1612,0
Vykurovanie	1	Automatická regulácia a nočný útlm teploty	18424,0	35816,3	59639,9	102500,0	1,7	2,9	30,8
	2	Zateplenie distribučného systému ÚK	12896,8	25071,4	11955,3	31795,6	0,5	1,3	8,3
	3	Rekonštrukcia kotolne (nový kotol, príslušenstvo,...)	18160,8	35304,6	191193,4	271704,4	5,4	7,7	87,9
	4	Hydronické vyregulovanie a inštalácia termostat. ventilov	46849,6	91075,6	150830,4	356342,0	1,7	3,9	96,3
		Spolu	96331,2	187267,8	413619,1	762342,0	2,2	4,1	223,4
Teplá úžitková voda	1	Úsporné sprchové hlavice	16581,6	32234,6	65680,4	139277,6	2,0	4,3	38,9
	2	Termostatický zmiešavač	11054,4	21489,8	71628,5	119380,8	3,3	5,6	36,3
	3	Automatická regulácia TÚV	2105,6	4093,3	10563,3	19753,2	2,6	4,8	5,8
	4	Zateplenie distribučného systému TÚV	3421,6	6651,6	11061,3	24670,6	1,7	3,7	6,8
		Spolu	33163,2	64469,3	158933,5	303082,2	2,5	4,7	87,8
Celkom			228984,0	445144,9	4205134,0	5918215,0	9,4	13,3	1923,1

Úspory pre jednotlivé alternatívy	Úspory [%]	58,5

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4. Graphical presentation

- Energy savings:
  - Building Envelope (blue)
  - Heating System (green)
  - Hot Water (red)
- Energy consumption before / after
- contribution percentage of each profession

PS-82-PP radovy 8NP BA
Súbor Nápoveda
Fotodokumentácia | Výkresová dokumentácia | Popis stavebnej sústavy | Technicko-ekonomické vyhodnotenie | Grafické zobrazenie | Čo je to energetický audit
Grafické zobrazenie potenciálu úspor energií
Hodnoty úspor energie (kWh/rok)
Opatrenia podľa číselného a farebného zobrazenia
1- - Zateplenie obvodového plášťa
2- - Zateplenie podlahy, resp. stropu nad nevykurovaným podlažím
3- - Zateplenie strechy
4- - Výmena transparentných výplní
5- - Automatická regulácia a nočný útlm teploty
6- - Zateplenie distribučného systému ÚK
7- - Rekonštrukcia kotolne (nový kotol, príslušenstvo,...)
8- - Hydronické vyregulovanie a inštalácia termostat. ventilov
9- - Úsporné sprchové hlavice
10- - Termostatický zmiešavač
11- - Automatická regulácia TÚV
12- - Zateplenie distribučného systému TÚV
Grafické zobrazenie spotreby energie
1- - Energetická úspora
2- - Energetická spotreba po implementácii opatrení
3- - Energetická spotreba pred implementáciou opatrení
Energia (kWh/rok)
PO a PRED implementáciou energeticky úsporných opatrení
Percentuálny podiel energeticky úsporných opatrení
- Stavebné konštrukcie
- Vykurovanie
- Teplá úžitková voda
14,5 %
43,4 %
42,1 %
start
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Microsoft Excel ...
C:\Documents a...
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SK
22:37

Conclusion

- **Aim**
  - Reducing of input values and easy handiness of our application
  - Accuracy from 10-20% (it can not replace computer energy evaluations)
  - For purposes of the First Building Society Saving Bank in Slovakia

- **Result for the praxis**
  - Reduce the nowadays high energy consumption in existing buildings
  - Increasing of the commercial value of the building
  - Improvement of the living standard

Thank you for your attention